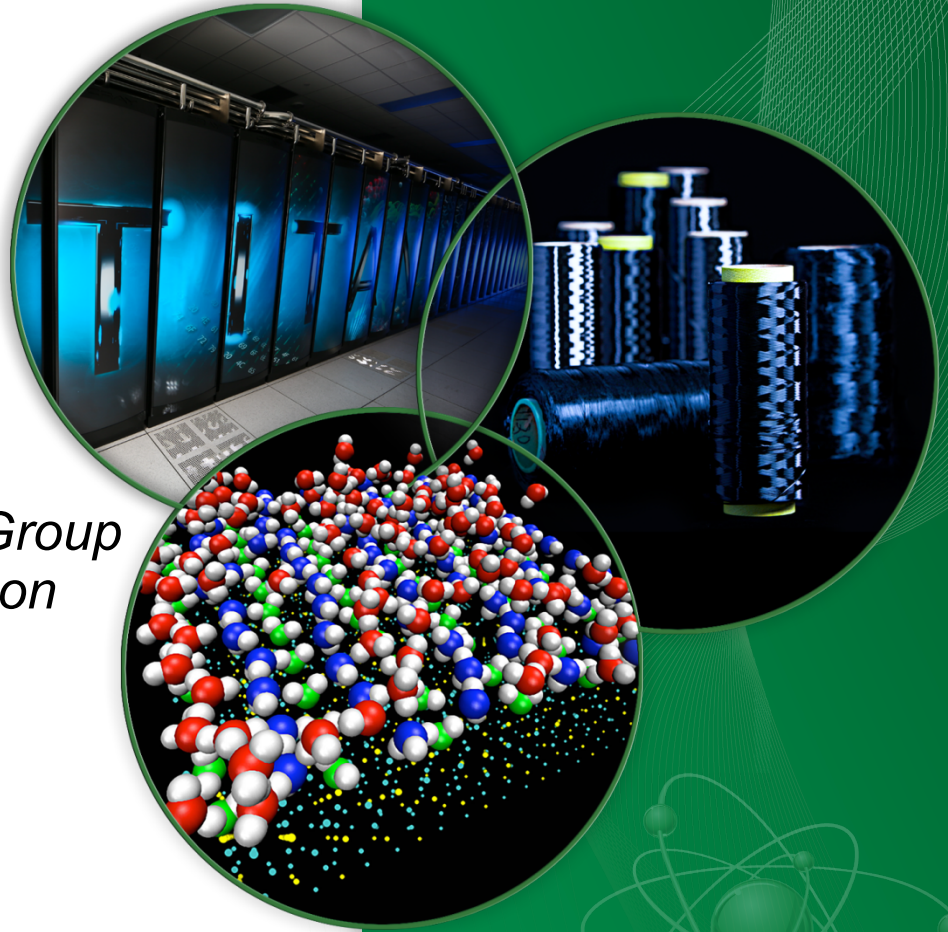# Nuclear Data Adjustment with SAMMY Based on Integral Experiments

Vladimir Sobes*
Luiz Leal
Goran Arbanas

*Nuclear Data and Criticality Safety Group
Reactor and Nuclear Systems Division
Oak Ridge National Laboratory*

sobesv@ornl.gov

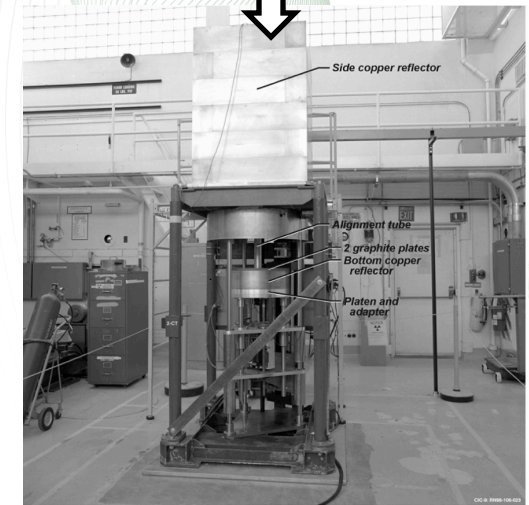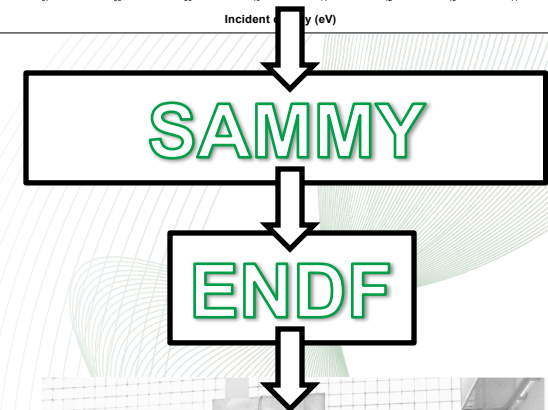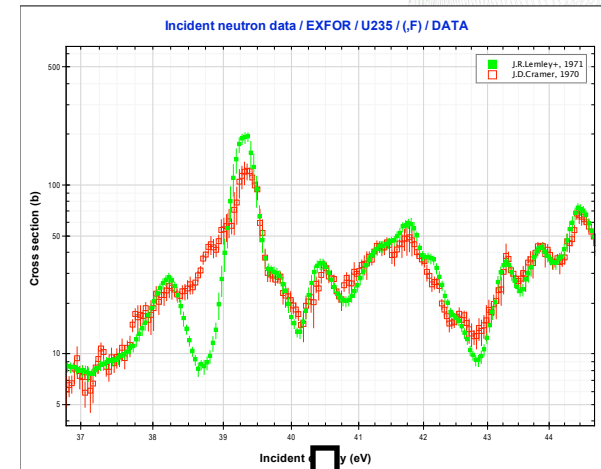OAK RIDGE
National Laboratory

SAMINT: A Code for Nuclear Data Adjustment with SAMMY Based on Integral Experiments

- Allow coupling of differential and integral data evaluation in a continuous-energy framework

- Update the parameters of a resolved resonance region evaluation directly based on integral benchmark experiments
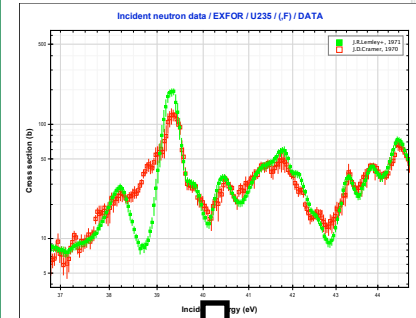
OAK RIDGE
National Laboratory

Traditional SAMMY Evaluation

- Traditionally SAMMY has used differential experimental data ($\sigma(E_i)$ vs E_i) to adjust nuclear data parameters:

  - Resonance energies

  - Resonance widths

  - Number of prompt neutrons per fission

  - Etc…

- Integral experimental data, such as ICSBEP benchmarks, have remained only a tool for validation of completed nuclear data evaluations.

Incident neutron data / EXFOR / U235 / (,F) / DATA

J.R.Lemley+, 1971
J.D.Cramer, 1970

SAMMY

ENDF

Side copper reflector
Alignment tube
2 graphite plates
Bottom copper reflector
Platen and adapter

OAK RIDGE
National Laboratory

Integral Experiments to Aid Nuclear Data Evaluation

- SAMINT can be used to extract information from integral benchmarks to aid the nuclear data evaluation process.

- Near the end of the evaluation based on differential experimental data, integral data can be used to:

  - Resolve remaining ambiguity between differential data sets

  - Guide the evaluator to troublesome energy regions

  - Inform the evaluator of the most important nuclear data parameters to integral benchmark calculations

 - Improve the nuclear data covariance matrix evaluation

SAMINT
Proper Uses

- SAMINT **is not intended** to bias the nuclear data towards fitting a certain set of integral experiments

- SAMINT should be used to **supplement** evaluation of differential experimental data

- Using the GLLS methodology ensures that the update nuclear data parameters respect the original fit of the differential data

Using SAMINT with SAMMY

Differential Experimental Data
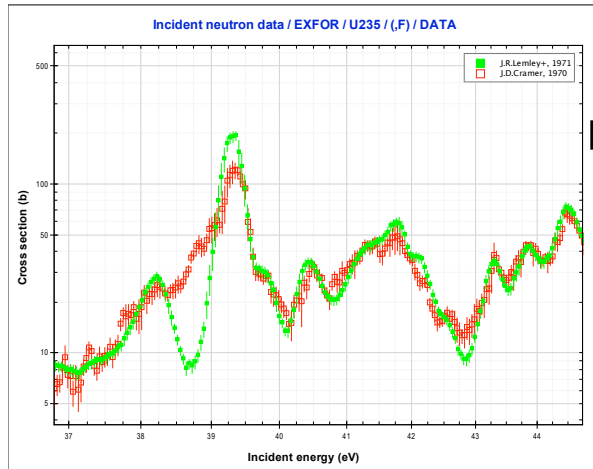
Integral Experimental Data

SAMMY → dσ(E)/dP → SAMINT → dk/dP → SAMMY → Updated P and δP → ENDF

dk/dσ(E) ← CE TSUNAMI MCNP-6

P stands for all resonance parameters: E_λ, Γ_γ, Γ_n, Γ_f, etc.

OAK RIDGE
National Laboratory

SAMINT Today and Tomorrow

Current Capabilities

- Adjusting resolved resonance parameters and associated covariance

- Adjusting number of prompt neutrons per fission

- Calculating continuous energy cross sections and eta values (reactor physics) to satisfy integral benchmarks

- Works with both CE TSUNAMI and MCNP-6 k-eigenvalue sensitivities

- Iteration for non-linearity

Future Developments

- Near term:
  - Expansion to the unresolved resonance region

- Long term:
  - Expansion to high energy region
  - Adjustment of angular distribution data and associated covariance
  - Support for future TSUNAMI generalized sensitivity theory developments

OAK RIDGE
National Laboratory

Results and Analysis

- SAMINT used to improve resolved resonance region evaluation of ^{56}Fe which had previously given discrepant results.

- Four integral experiments from the ICSBEP were selected.

- Energy region of evaluation: 1e-5 eV to 2 MeV.

- 1190 resonance parameters varied:

  - Γ_γ: 450 keV – 2MeV

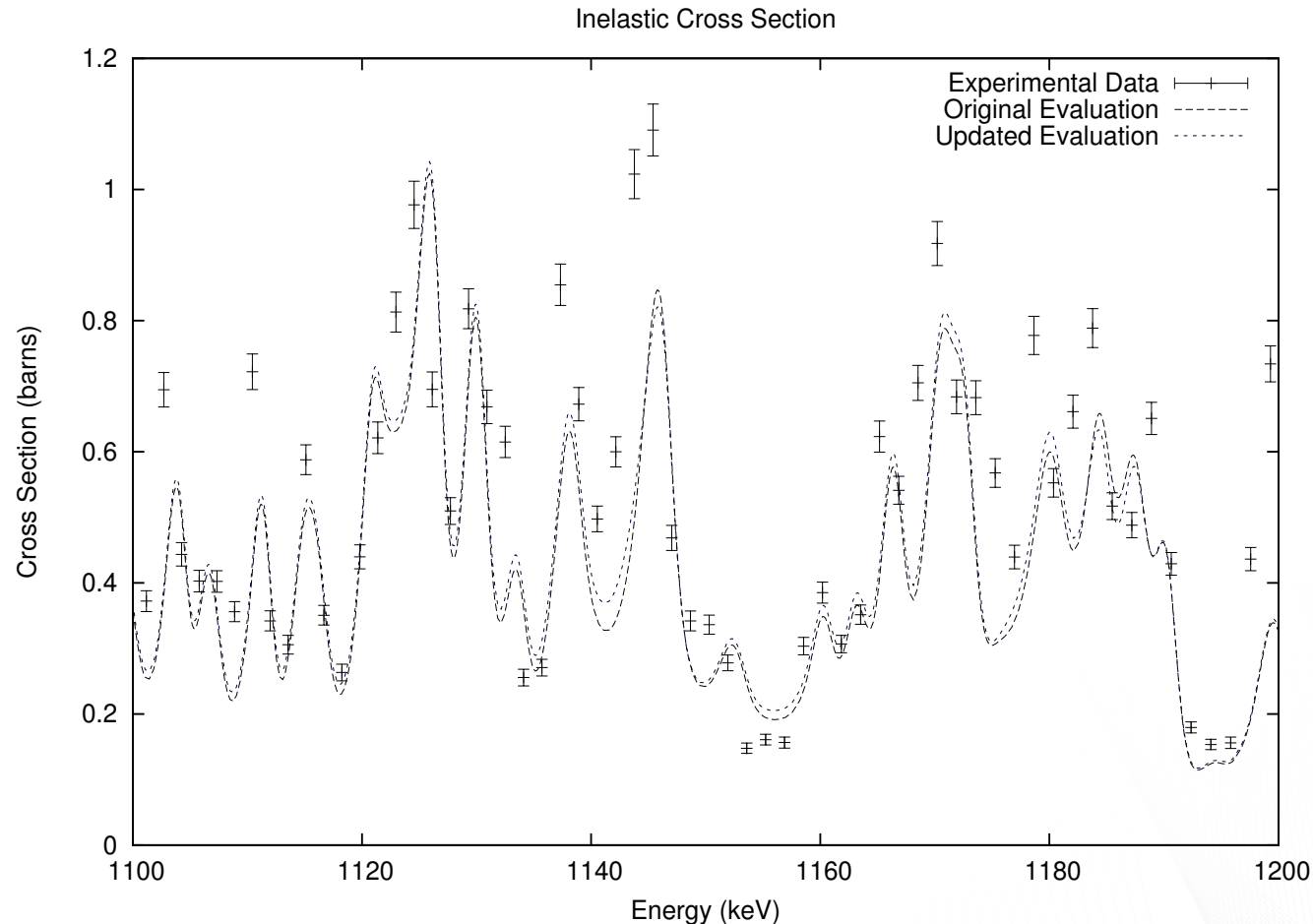 - $\Gamma_{(n,n'),1}$ and $\Gamma_{(n,n'),2}$: 846 keV – 2MeV

OAK RIDGE
National Laboratory

⁵⁶Fe Results
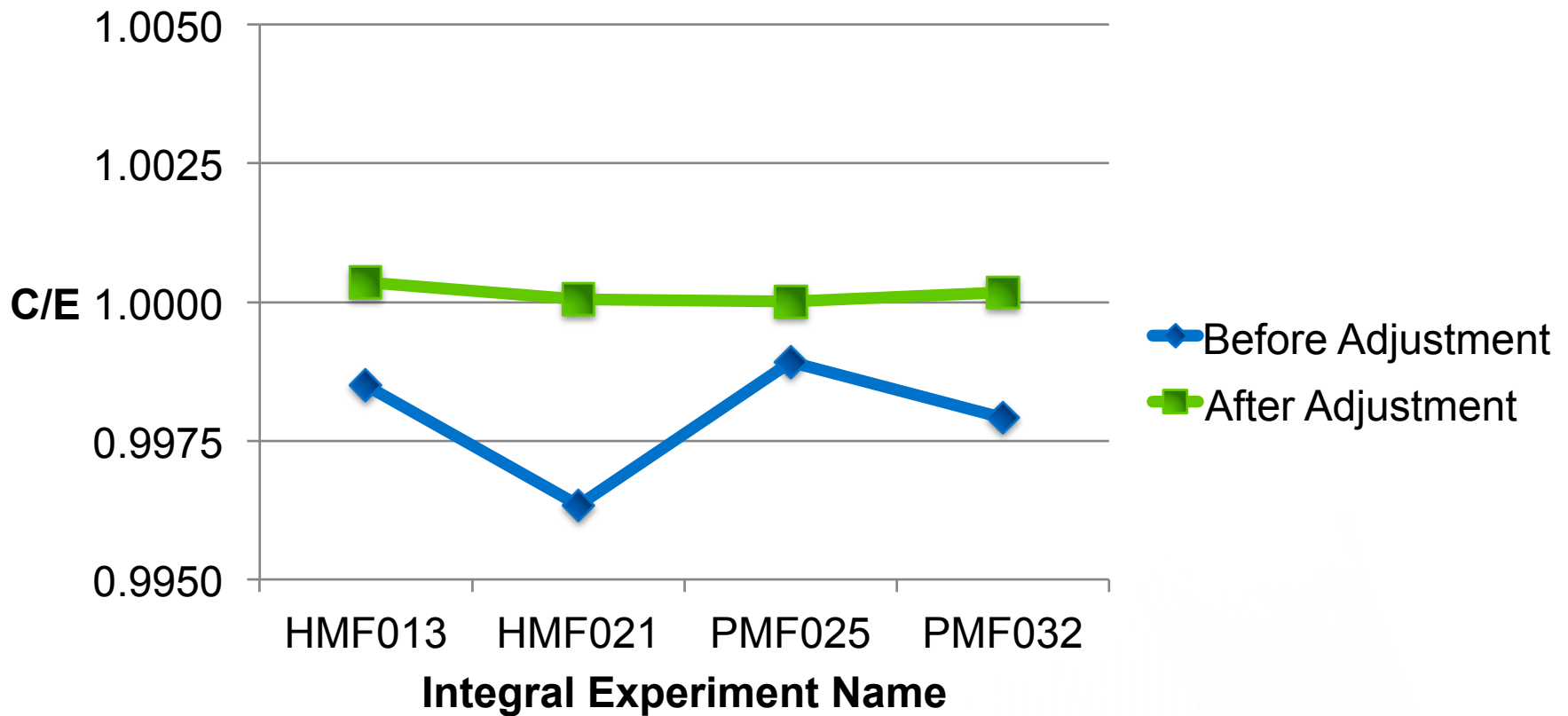
- **C/E**: $$\frac{\text{Computed Value}}{\text{Experimentally Measured Value}}$$

OAK RIDGE
National Laboratory

Cross Section Changes:
Finer Scale than Differential Experimental Data

Inelastic cross section of ^{56}Fe before ($\chi^2 = 73.3382$) and after ($\chi^2 = 73.6877$) the adjustment based on integral experimental data plotted on top of differential experimental data of Plompen, presented with one standard deviation error bars.
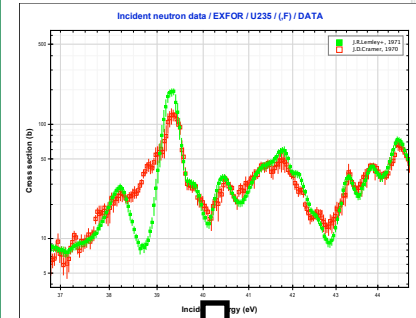
OAK RIDGE
National Laboratory

Cross Section Changes:
Finer Scale than Differential Experimental Data
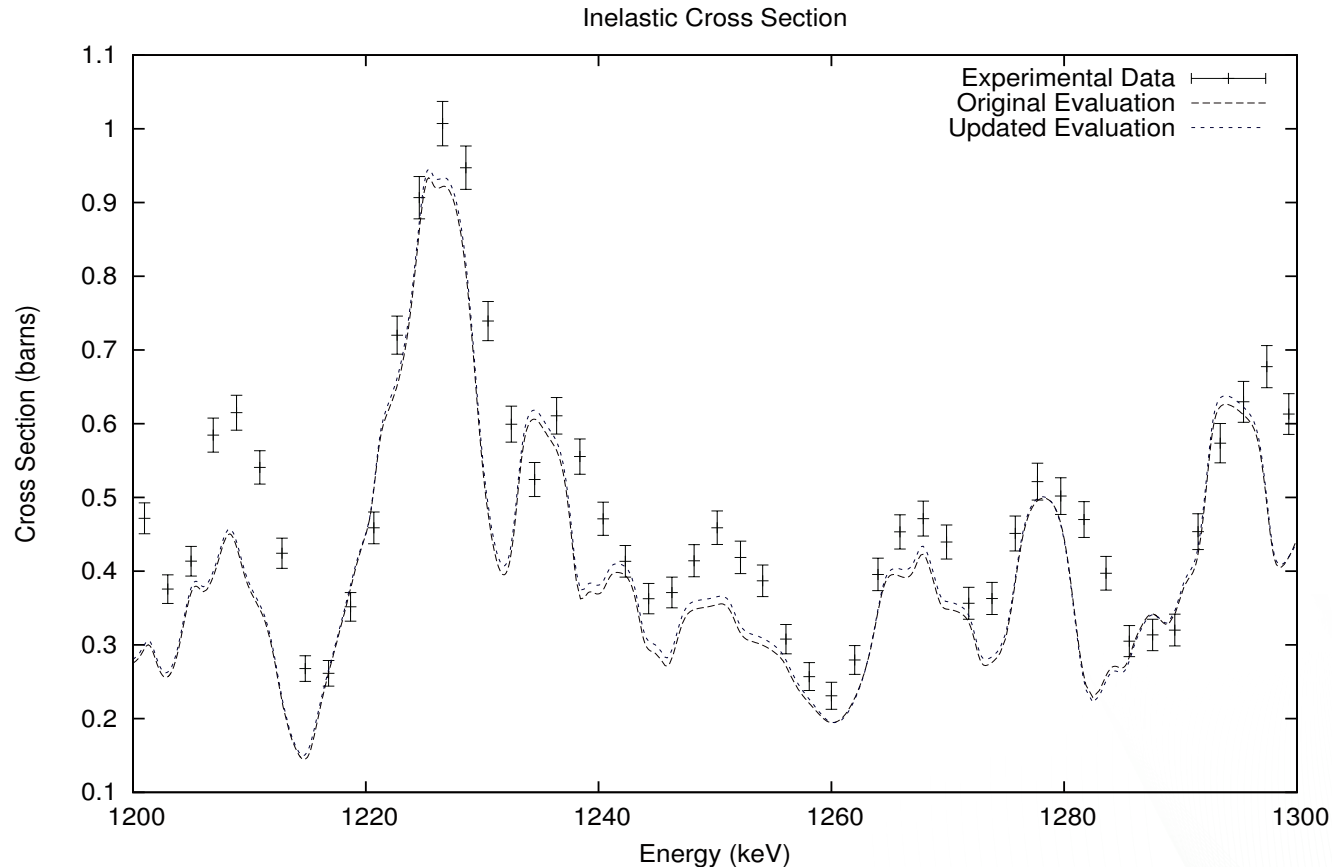
Inelastic cross section of ^{56}Fe before ($\chi^2 = 23.6023$) and after ($\chi^2 = 22.9036$) the adjustment based on integral experimental data plotted on top of differential experimental data of Perey, presented with one standard deviation error bars.

OAK RIDGE
National Laboratory

Summary

- SAMINT should be used to **supplement** evaluation of differential experimental data.

- SAMINT will also improve the nuclear data covariance matrix evaluation.

- Plans to extend the SAMINT methodology to the unresolved resonance region and the high energy region.

SAMMY

ENDF